Space Weather Technical Forecast

Issued on Tuesday 18 March 2025 at 13:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares (R1-R2; Minor-Moderate radio blackouts) throughout. Chance G1/Minor Storms days 2-4 due to CME arrivals. Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with a peak flare reaching M1.0 at 17/1933 UTC associated with a filament eruption in the northeast.

There are fourteen active regions on the visible disc. AR4025 in the northwest is the largest spot at present, with recent growth observed in it's trailing portion. AR4028 in the southeast is of similar size, with slight proliferation of intermediate spots. AR4031 in the north near centre disk continues to show minor growth. None of the above spots are showing any significant magnetic complexity, with the remainder of the spots, smaller and apparently stable. Three unnumbered regions have been noted, two in the east, one in each hemisphere and small. The final region is developing just ahead of AR4025 in the northwest, it appears to be developing moderately quickly with a continuing risk it may interact with AR4025.

Several CMEs were observed leaving the Sun, three of which may have an Earth directed component. There are three main CMEs which feature in the forecast, the first is from a filament eruption which occurred in the northeast quadrant, within the vicinity of CH24/-, at 16/2020 UTC, possibly arriving late 19 Mar. The second CME was from a filament eruption in the northwest around 17/1030UTC, just ahead of AR4025 with ejecta clearly leaving to the west, though a faint halo can be seen later on StereoA imagery, possibly arriving 20 Mar. The third CME was associated with the 17/1930UTC M1.0 flare and filament eruption from a region of plage in the northeast, perhaps arriving early on 21 Mar.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, showed slow-ambient to slightly elevated levels in the range 350-420 km/s. Density was near average. Interplanetary Magnetic Field, Bt, was weak, below 8nT, with the north-south component, Bz, also weak and variable, ranging between +6/-7nT. Phi angle was mostly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at background levels. High energy electron flux (greater than 2 MeV) was Moderate to High,

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with a peak of 6680pfu at 17/1600 UTC. The 24-hour fluence was above the Active (1e8 integrated pfu) throughout, reaching 1.7e8 integrated pfu at 18/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with an ongoing chance of further isolated M-class flares.

Solar Wind / Geomagnetic Activity: The fast wind enhancement from CH22/- has now eased with solar winds near background at around 400km/s with no significant coronal hole enhancements expected in the period. Slightly elevated or elevated enhancements are probable due to CME arrivals.

Quiet to Unsettled activity is expected initially, with a chance of G1-G2/Minor-Moderate storms days 2-4 (19-21 Mar) should any of three possible CMEs arrive and/or combine.

Energetic Particles / Solar Radiation: High energy proton flux is expected to be at background levels, with a slight chance of enhancement should there be any larger flares. High energy electron flux is expected to continue to reach high levels at the diurnal maxima, with Active (1e8 integrated pfu) fluence continuing days 1-2 (18-19 Mar) before potentially easing. Confidence lowers later in the period.

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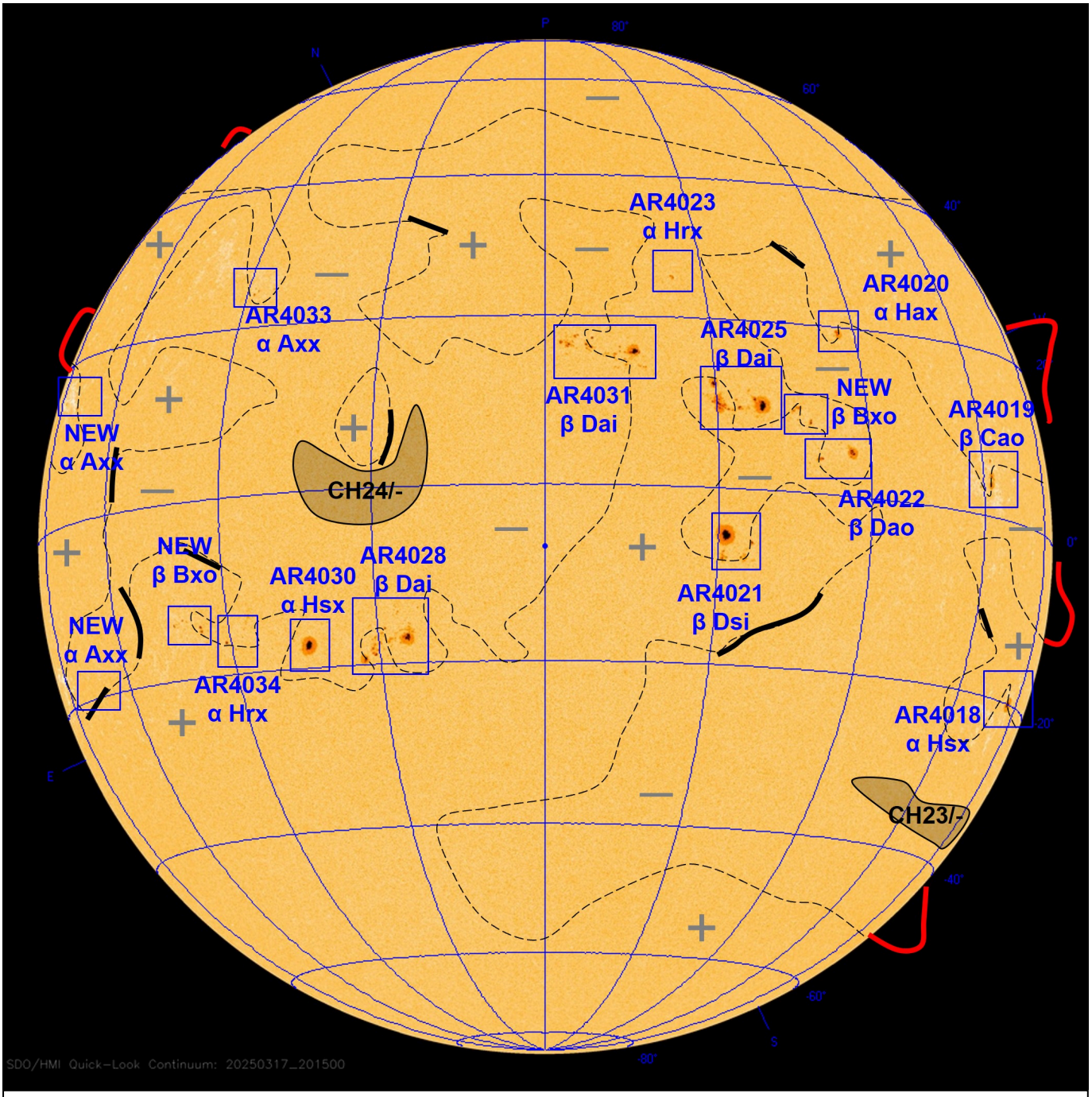
Figure 1: Solar synoptic chart valid 18/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Numerous CMEs were observed on 16 and 17 Mar, many with a lack of a clear source. There are three main CMEs which feature in the forecast, the first is from a filament eruption which occurred in the northeast quadrant, within the vicinity of CH24/-, at 16/2020 UTC. This produced a partial halo CME in coronagraph imagery, with an associated shock evident. This has been analysed, as results suggest a glancing blow arriving at Earth either late on day 2 (19 Mar) or early on day 3 (20 Mar). Given the filament was near CH24/-, there may have been some deflection towards the south and west, which is currently under consideration. The second CME was from a filament eruption in the northwest around 17/1030UTC, just ahead of AR4025 with ejecta clearly leaving to the west, though a faint halo can be seen later on StereoA imagery. A new sunspot formed in this location shortly after. The third CME was associated with the 17/1930UTC M1.0 flare and filament eruption from a region of plage in the northeast. This CME mostly travelled north, but once again may have an Earth Directed component, perhaps arriving early on day 4 (21 Mar).

Otherwise, the fast wind enhancement from CH22/- has now eased with solar wind speeds near background at around 400km/s with no significant coronal hole enhancements expected in the period.

Quiet to Unsettled activity is expected initially, with a chance of G1-G2/Minor-Moderate storms days 2-4 (19-21 Mar) should any of three possible CMEs arrive and/or combine.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	40	30	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
17/0253	Partial	Filament Eruption	Northeast	580	19/2100	A large shock associated with this CME.
17/1809	Partial	Filament Eruption	Northwest	600	20/1800	Low confidence on exact timing due to interactions with other CMEs. May combine.
18/0215	Partial	Filament Eruption	Northeast	520	21/0100	Low confidence. Chance of a glance.

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Figure 2: MOSWOC Enlil showing numerous CMEs.

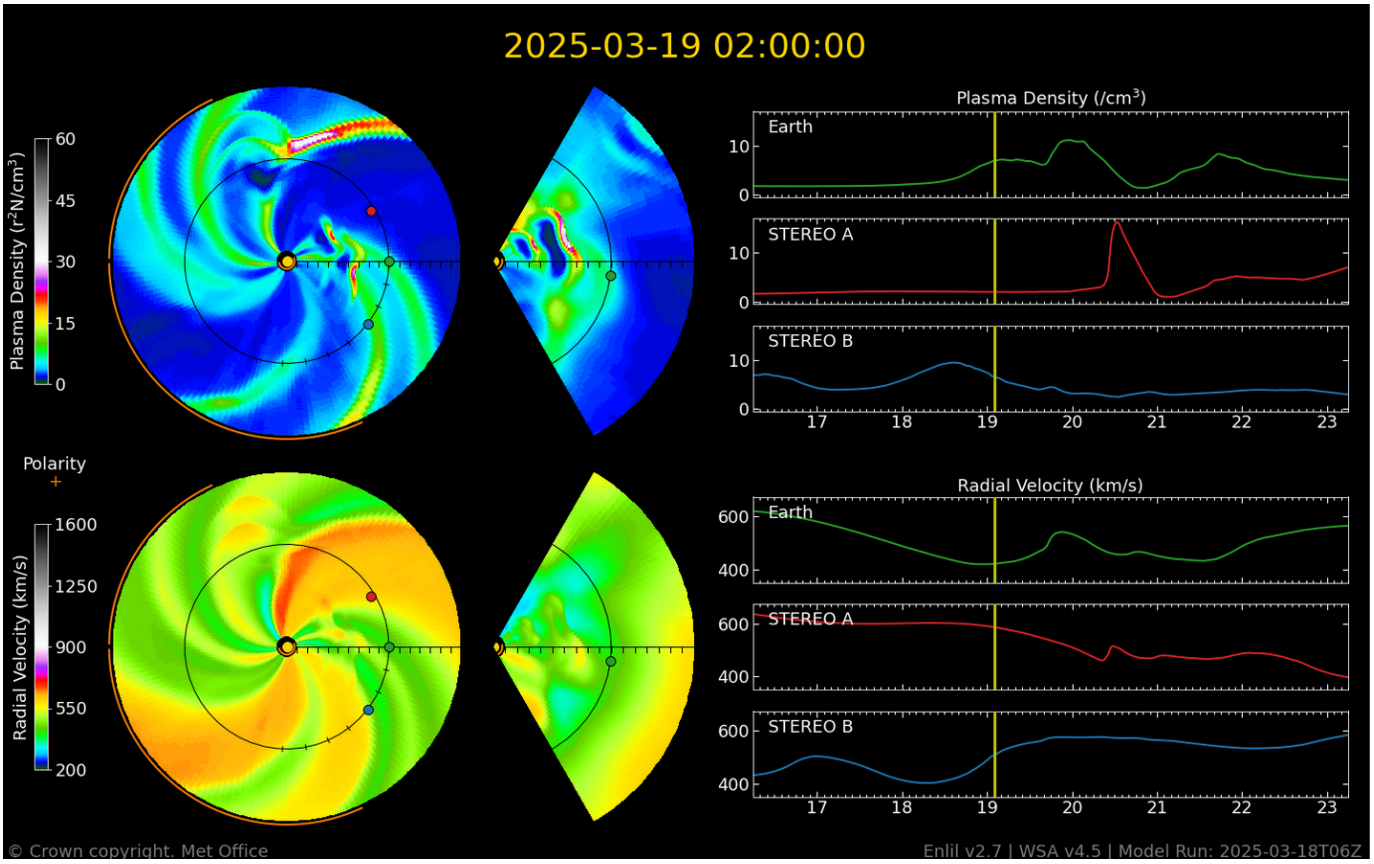

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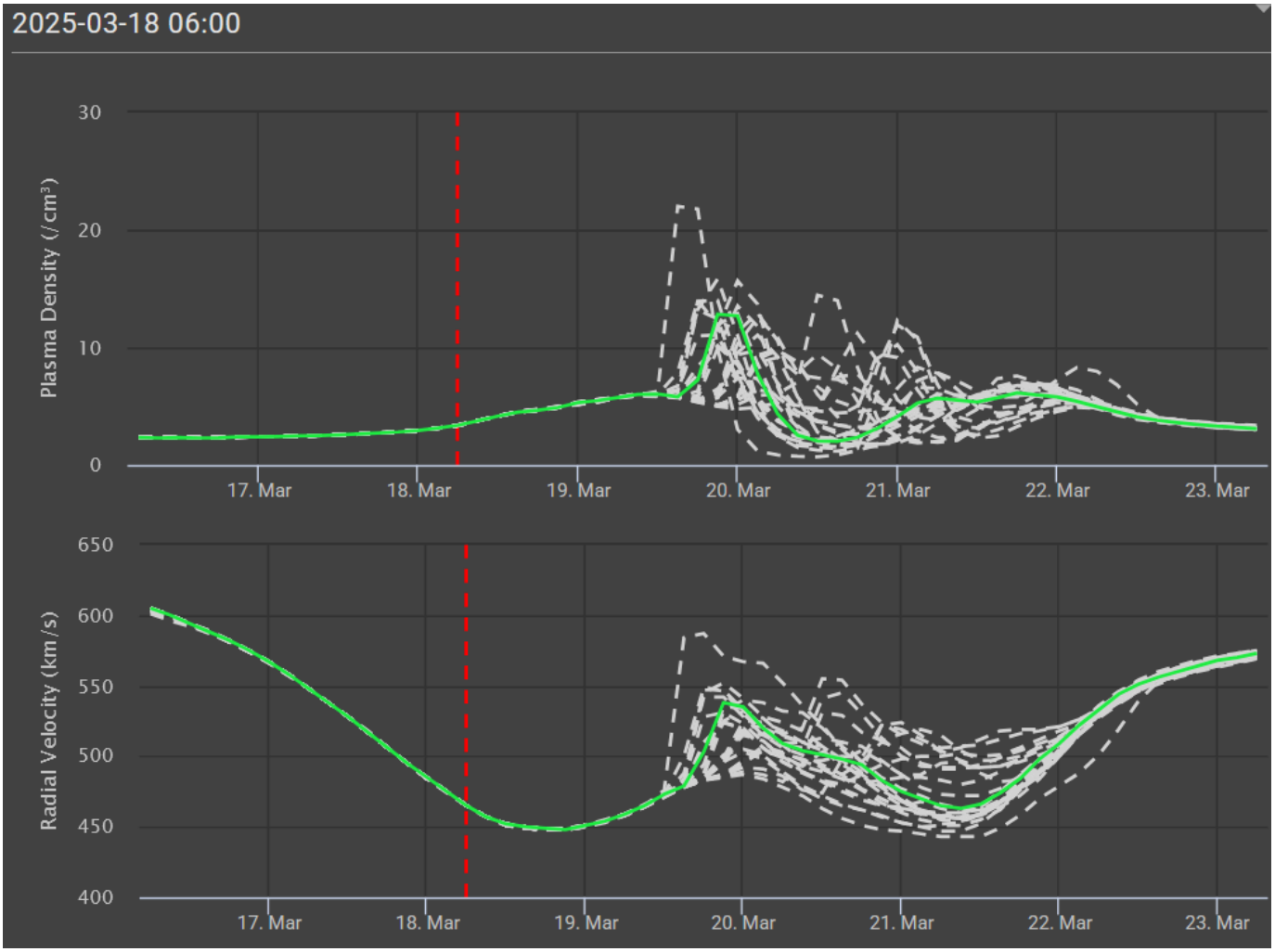
Figure 3: MOSWOC Enlil Ensemble showing numerous peaks in density and velocity in coming days.



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Radio Blackouts - X-Ray Flares

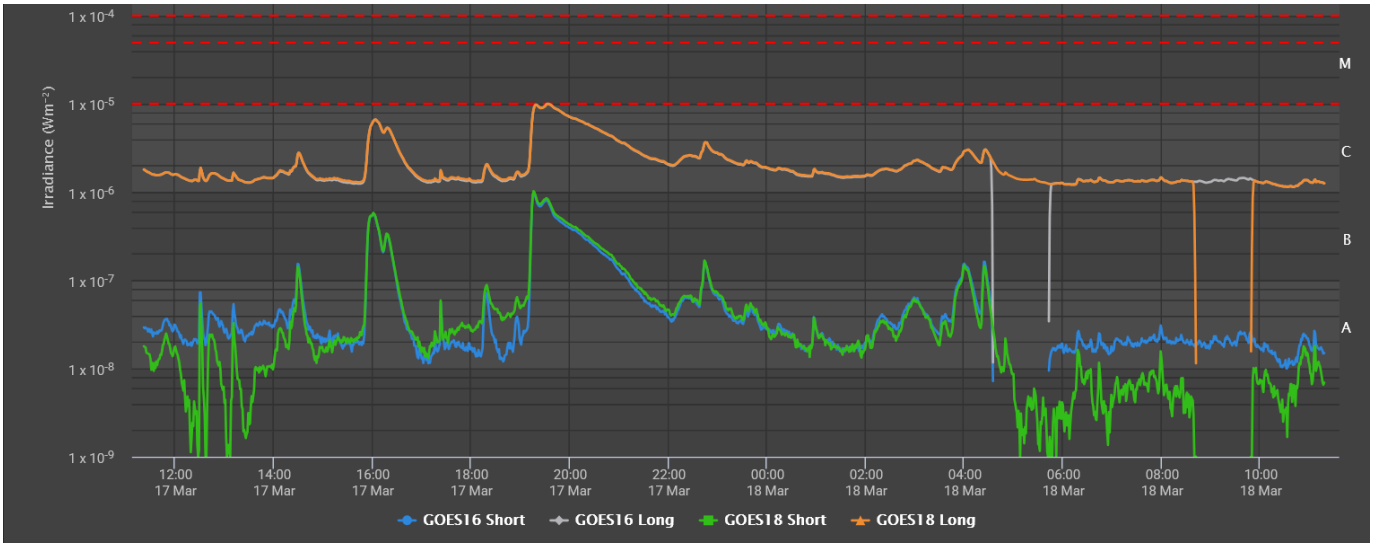
Solar activity has been Moderate, with a peak flare an M1.0 at 17/1933 UTC associated with a filament eruption in the northeast.

Fourteen sunspot regions cover the visible disc. AR4025 in the northwest is the largest spot at present, with recent growth observed in it's trailing portion, combined with simplification of the intermediate spots. AR4028 in the southeast is of similar size, but along with AR4031 in the north near centre disk show little change. None of the above spots are showing any significant magnetic complexity, with the remainder of the spots, smaller and apparently stable. There are currenly three unnumbered regions.

Low to Moderate activity is expected, with a chance of further M-class flares.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	40	40	30	40
Very Active	R3-R5 (X Class)	No	5	5	5	5

Figure 4: Past 24 hour X-Ray flux at GEO from GOES data.



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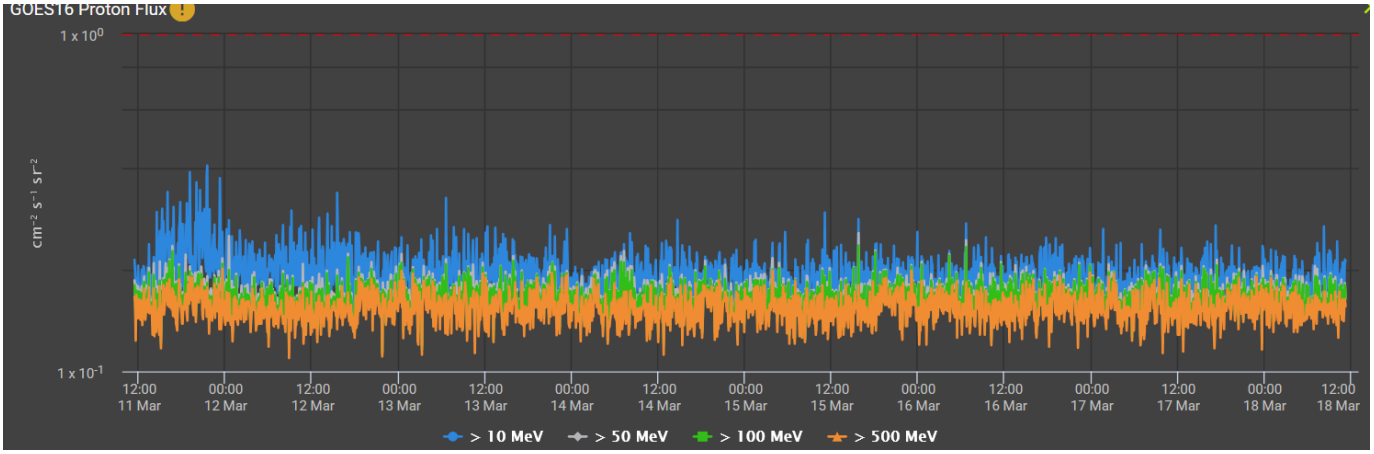
Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux is expected to remain at background levels, with only a slight chance of enhancement due to the current inactivity and magnetic simplicity of the small regions on the Earth-facing disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: Proton flux data at GEO over the past week with no significant enhancements noted.



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High Energy Electrons (≥ 2MeV)

GOES16 High energy (>2MeV) Electron flux has been varying between Moderate and High on the satellites diurnal cycle, as a result of the recent connection to coronal hole fast winds, and the subsequent outward expansion of the charged Van Allen belts as this wind eases. Flux is expected to continue varying diurnally between Moderate and peak High, but with both the period of High flux and peak values are expected to gradually decrease through the period. With possible CME arrival/s due 19th and 20th, this may serve to clear some electrons from their orbits, reducing flux on subsequent days.

The associated 24 hour fluence is expected to continue above Active (1e8 integrated pfu) at first, but with lower confidence for this to persist into days 3-4 (20-21 Mar). A declining trend is most probable, though likely at a slower rate than the recurrence and MOSWOC REFM model are forecasting. The possible CME arrival/s 19th and 20th, may lower chance of reaching Active on subsequent days, and this gives rather more uncertainty in the guidance than usual.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	Yes	100	70	50	20
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	10	10	1	1

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Figure 6: Recent electron flux and MOSWOC REFM fluence forecast/observations/recurrence.

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